

Background

noxious phytoplankton, some protists, cyanobacteria.

and benthic algae. These blooms can impact virtually

all components of aquatic ecosystems, cause serious

Agency has the resources or mandate to address the

Ecology and Oceanography of Harmful Algal Blooms

illness in humans in a variety of ways, and have a

significant impact on water quality. Since no single

interagency extramural research program on the

(EcoHAB) was formed in 1997. This joint funding

effort enhances interagency communication and

allowing for the most effective use of federal

resources

eliminates funding redundancy between agencies.

How Research Addresses

the Water Quality MYP

How Research Contributes to

Outcomes

EPA-sponsored EcoHAB projects produce results that

eutrophication, and the occurrence and consequences

of harmful algal blooms (HABs). Research results will

assessments for nutrients, as well as the development

and predicting the relationship between stressors such

ecosystems. Ultimately, the expected outcomes of the

of stressor-response models aimed at understanding

as nutrients, eutrophication, and hypoxia on aquatic

EcoHAB program as a whole are 1) enhanced HAB

forecasting efforts; 2) improved control and mitigation

options for decision makers concerned with managing

HABs; and 3) improved bloom prevention strategies

based on an advanced understanding of the

formation, maintenance, and decline

conditions and processes that promote bloom

MYP Science Question: The question under Long

Term Goal 2 of ORD's Multi-Year Plan (MYP) as

addressed by EcoHAB is: How can multiple and

changel of biological impairment IHABs, toxin

observations, and cause-effect modeling?

will further the scientific understanding of the

relationships between nutrient inputs, coastal

enhance the development of ecological risk

production] be inferred from indicator and other

possibly-related causes feutrophication, land use

many dimensions of the HAB problem, an

Harmful Algal Blooms (HABs) include toxic and

HARMFUL ALGAL BLOOM RESEARCH AND THE ECOHAB PROGRAM

Gina Perovich ORD/NCER





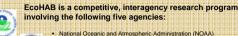
CINCINNATI, OHIO JANUARY 2006

EcoHAB Objectives

Health and Ecosystem Effects

(PCR) algal

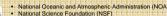
species probe



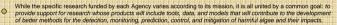
Ecology and Oceanography

of Harmful Algal Blooms





- Office of Naval Research (ONR)
 - National Aeronautics Space Administration (NASA)
- . EPA's Science to Achieve Results (STAR) program



- EPA's earlier efforts in the EcoHAB program were largely focused on detection methods, toxin identification and lifehistory studies of HABs, with a heavy emphasis on Pfiesteria, as mandated by Congress.
- In recent years, EPA has moved away from this focus, encouraging research on other harmful algal species in an effort to better support the Agency's mission. Now, in direct support of the MYP, EPA's specific goal within the larger EcoHAB. framework is to better understand the relationships between nutrient loading (eutrophication). HABs, and food web dynamics.

EcoHAB: Dinoflagellate Molecular Ecology David Oldach, University of Maryland, Baltimore

This research developed real-time PCR assays to detect HAB species.

Science Question:

Harmful algal species are found throughout the Chesapeake Bay and Coastal Bays but identification using light microscopy is difficult when assessing species in heterogeneous environmental samples. Can rapid and sensitive assays be developed to identify HAB species in complex environmental samples?

Methods:

Sequence data for target loci were compared in a matrix and primers and probes were designed based on level of specificity desired (i.e. group-specific or species-specific). Assays were designed and validated for Pflesteria piscicida. P. shumwayae Karlodinium micrum. Chattonella verruculosa, C. cf. verruculosa, C. marina, C. subsalsa, Fibrocapsa japonica, Heterosigma akashiwo, Pseudo-nitzschia sp. and Aureococcus anophagefferens.

Outputs and Outcomes:

- Successful development of molecular probes and techniques for rapid identification of several HAB species
- · Researchers developed collaborations with local Departments of Natural Resources Maryland DNR utilizes this grant's PCR results for its water quality monitoring program.
- . Based on the successful development of probes, additional funding has been awarded to these laboratories to correlate HAB presence with human health (CDC, NC Dept. of Health and Human Services); determine spatial and temporal distribution (funding by various states, NOAA, USEPA, NC Sea Grant Program); and to assess presence of HAB species in sediment and ballast water (STAR, DoD)
- To date, 113 HAB sequences have been deposited to GenBank.
- All of these are accessible to the scientific community for research purposes.

**All data and accompanying figures provided courtesy of the principal investigator listed for each grant



Examples of Extramural Research Projects

EcoHAB: Physiology and Ecology of Macroalgal Blooms on Coral Reefs. Off of Southeast Florida

PI: Brian E. Lapointe, Harbor Branch Oceanographic Institution, Florida This research addresses fundamental questions regarding the recent proliferation of

macroalgal HABs on coral reefs off Southeast Florida.

Science Question:

 Are macroalgal blooms in Southeast Florida linked to increasing land-based discharges of ammonium derived from sewage via groundwater and ocean

Expected Outputs and Outcomes:

- An advanced understanding of how physical, chemical, and biological factors interact to initiate, sustain, and terminate macroalgal blooms on coral reefs in southeast Florida.
- A determination as to whether these blooms are being driven. by low-level buildup of ammonium from land-based sources of nutrient pollution

Methods:

- This project is a two-year study of the physiology and ecology. of Codium and Caulerna spp. whose methods include:
 - . Measuring seasonal patterns in benthic cover via underwater digital photography
 - · Measuring photosynthesis, dark respiration, optical properties, tissue C:N:P ratios and &15N values Measuring the uptake of NH,* and NO,* under
 - different combinations of irradiance and temperature · Conducting controlled grazing experiments in both
 - the lab and field to quantify the potential for generalist and specialist herbivores to control the hlooms

EcoHAB: Control of Harmful Algal Blooms Using Clay

Donald M. Anderson, Woods Hole Oceanographic Institution Richard Pierce: Associate Investigator (Mote Marine Laboratory) Richard M. Greene (EPA Gulf Ecology Division) Michael Lewis (EPA Gulf Ecology Division)

This research investigates bloom mitigation strategies so that impacts to human health. fisheries and ecosystems can be minimized.

V. Monica Bricelj (Institute for Marine Biosciences, National Research Council Canada)

- . Clays are effective, fast-acting, and can be relatively selective for particular HAB
- . Clavs may be able to remove some dissolved algal toxins in seawater.
- . Polyaluminum chloride (PAC), a chemical coagulant, has advantages and disadvantages, and should be investigated further.
- consequences are unknown.
- addressing a highly visible and serious environmental problem in the coastal ocean
- coagulant manufacturers, environmental consulting companies and citizens groups concerned about red tide impacts.
- . A planned pilot study (funded by NOAA) will address the "real-world issues" of clay dispersal and its effects in the field.

Interactions with Customers

The ultimate beneficiaries of EcoHAB research funded by all of the Agencies are the individuals and organizations who are directly impacted by HABs or who must manage these blooms and their impacts.



This FPA-funded EcoHAB grant allowed investigators to form collaborations with Maryland Department of Natural Resources and Delaware Department of Natural Resources and Environmental

Control to use their technique to assay environmental water samples for their monitoring programs. In fact, Maryland DNR utilizes the PCR results to 1) rapidly assess presence of HAB species during a bloom and/or fish kill event; 2) determine if further testing such as bioassay experiments are needed in an area: and 3) inform the public and scientific community of HAB events through their website: www.dnr.state.md.us



Research results from this EPA-funded EcoHAB grant are being used by state of Florida (Department of Environmental Protection, Florida Wildlife Research Institute) as well as federal agencies (US

EPA) in an on-going risk assessment of alternatives for wastewater treatment and disposal in Southeast Florida. The results are also being used by researchers and resource managers in SEFCRI (Southeast Florida Coral Reef Initiative, an element of the federal International Coral Reef Initiative, ICRI) charged with improving our understanding of landbased sources of pollution in this geographic area.



Investigators on this EPA-funded EcoHAB grant worked closely with Solutions to Avoid Red Tide (S.T.A.R.T.), a citizens group

established in Florida to help find solutions for red tide problems. In order to perform pilot scale treatments of natural Florida red tides, this work required the approval and cooperation of several state and federal agencies involved in oversight of coastal water quality and resources. These included: Florida Department of Environmental Protection, Florida Marine Research Institute, EPA, and the U.S. Army Corps of Engineers.

For more information on these, and other EcoHAB grants, please visit our website at www.epa.gov/ncer



Science Question:

Is the use of clay flocculation to remove HAB cells from the water column a promising mitigation strategy for HABs?

Methods:

Scientists used laboratory cultures. aguaria, and mesocosms to evaluate the efficiency of this technique and characterize potential effects of its use on the environment.

Outputs and Outcomes:

- A successful preliminary evaluation of the use of clays to mitigate harmful algal blooms, including such findings as:
 - . Clay dispersal remains a promising strategy for controlling HABs and their
- . Clavs can absorb or release inorganic nutrients, but the significance and
- . This project was a partnership between academic and government scientists.
- . Interactions were also initiated with clay producers, phosphate mining industry,